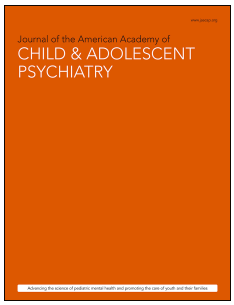
Accepted Manuscript



Association Between the Release of Netflix's *13 Reasons Why* and Suicide Rates in the United States: An Interrupted Times Series Analysis

Jeffrey A. Bridge, PhD, Joel B. Greenhouse, PhD, Donna Ruch, PhD, Jack Stevens, PhD, John Ackerman, PhD, Arielle H. Sheftall, PhD, Lisa M. Horowitz, PhD, MPH, Kelly J. Kelleher, MD, John V. Campo, MD

PII: S0890-8567(19)30288-6

DOI: https://doi.org/10.1016/j.jaac.2019.04.020

Reference: JAAC 2557

To appear in: *Journal of the American Academy of Child & Adolescent Psychiatry*

Received Date: 18 April 2019

Accepted Date: 25 April 2019

Please cite this article as: Bridge JA, Greenhouse JB, Ruch D, Stevens J, Ackerman J, Sheftall AH, Horowitz LM, Kelleher KJ, Campo JV, Association Between the Release of Netflix's *13 Reasons Why* and Suicide Rates in the United States: An Interrupted Times Series Analysis, *Journal of the American Academy of Child & Adolescent Psychiatry* (2019), doi: https://doi.org/10.1016/j.jaac.2019.04.020.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

Association Between the Release of Netflix's *13 Reasons Why* and Suicide Rates in the United States: An Interrupted Times Series Analysis

RH = *13 Reasons Why* and Suicide in the US

Jeffrey A. Bridge, PhD, Joel B. Greenhouse, PhD, Donna Ruch, PhD, Jack Stevens, PhD, John Ackerman, PhD, Arielle H. Sheftall, PhD, Lisa M. Horowitz, PhD, MPH, Kelly J. Kelleher, MD, John V. Campo, MD

Editorial
Supplemental Material

Accepted April 26, 2019

Drs. Bridge, Stevens, Sheftall, Kelleher, and Ruch are with The Research Institute at Nationwide Children's Hospital, Columbus, OH. Drs. Bridge, Stevens, Ackerman, Sheftall, and Kelleher are with The Ohio State University College of Medicine, Columbus, OH. Dr. Ackerman is also with Nationwide Children's Hospital Big Lots Behavioral Health Services. Dr. Greenhouse is with Carnegie Mellon University, Pittsburgh, PA. Dr. Horowitz is with the Intramural Research Program, National Institute of Mental Health, Bethesda, MD. Dr. Campo is with West Virginia University, Morgantown, WV.

Dr. Bridge was supported by grant R01-MH117594 from the National Institute of Mental Health, National Institutes of Health. The Extramural Division of the National Institute of Mental Health did not participate in the design and conduct of the study, in the collection, analysis, and interpretation of the data, or in the preparation, review, or approval of the manuscript.

Author Contributions:
Dr. Bridge had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Bridge, Greenhouse, Ruch, Stevens, Kelleher, Campo
Acquisition of data: Bridge, Ruch
Analysis and interpretation of data: All authors
Drafting of the manuscript: Bridge
Critical revision of the manuscript for important intellectual content: All authors
Statistical analysis: Bridge, Greenhouse, Ruch
Obtained funding: Bridge
Administrative, technical, or material support: Bridge, Ruch
Study supervision: Bridge, Greenhouse, Kelleher, Campo

Drs. Bridge, Greenhouse, and Ruch served as the statistical experts for this research.

Disclosure: Dr. Bridge has served on the Scientific Advisory Board of Clarigent Health. Drs. Greenhouse, Ruch, Stevens, Ackerman, Sheftall, Horowitz, Kelleher, and Campo report no biomedical financial interests or potential conflicts of interest.

ACCEPTED MANUSCRIPT

Correspondence to Jeffrey A. Bridge, PhD, The Research Institute at Nationwide Children's Hospital Center for Suicide Prevention and Research, 700 Children's Drive, Columbus, OH 43205; e-mail: Jeff.Bridge@Nationwidechildrens.org

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

Abstract

Objective: To estimate the association between the release of the Netflix series *13 Reasons Why* and suicide rates in the US.

Method: Using segmented quasi-Poisson regression and Holt-Winters forecasting models, we assessed monthly rates of suicide among individuals aged 10 to 64 years grouped into 3 age categories (10-17, 18-29, 30-64 years) between January 1, 2013, and December 31, 2017, before and after the release of *13 Reasons Why* on March 31, 2017. We also assessed the impact of the show's release on a control outcome, homicide deaths.

Results: After accounting for seasonal effects and an underlying increasing trend in monthly suicide rates, the overall suicide rate among 10- to 17-year-olds increased significantly in the month immediately following the release of *13 Reasons Why* (incidence rate ratio [IRR], 1.29; 95% CI, 1.09-1.53); Holt-Winters forecasting revealed elevated observed suicide rates in the month after release and in two subsequent months, relative to corresponding forecasted rates. Contrary to expectations, these associations were restricted to boys. Among 18- to 29-year-olds and 30- to 64-year-olds, we found no significant change in level or trend of suicide after the show's release, both overall and by sex. The show's release had no impact in the control analyses of homicide deaths within any age group.

Conclusion: The release of *13 Reasons Why* was associated with a significant increase in monthly suicide rates among U.S. youth aged 10 to 17 years. Caution regarding the exposure of children and adolescents to the series is warranted.

Key words: suicide, *13 Reasons Why*, suicide media reporting guidelines, time series

ACCEPTED MANUSCRIPT

INTRODUCTION

Suicide is a major public health concern in the United States, and the national age-adjusted rate increased 33% between 1999 and 2017.[1] One established public health approach to suicide prevention is accurate and responsible reporting of suicide in the news media and entertainment industry.[2,3] Responsible portrayals of suicide, mental illness, and related issues have the potential to promote awareness and help-seeking behaviors, reduce stigma, and refute misperceptions that suicide cannot be prevented.[4] Unfortunately, media depictions about suicide also have the potential to do harm, often through a process in which direct or indirect exposure to suicide increases the risk of subsequent suicidal behavior, known as suicide contagion.[5] Stories profiling someone who died by suicide appear to carry the greatest risk, as vulnerable individuals may identify with the person in the report, with youth potentially more susceptible to this effect.[6,7]

On March 31, 2017, Netflix released the series *13 Reasons Why*, based on the bestselling book of the same name.[8] The series portrays the story of an adolescent girl who kills herself following a sequence of traumatic life events that she catalogues before her death on 13 audiotapes and leaves behind for those she believes are at least partially to blame for her suicide. Since its release, the critically acclaimed and widely viewed series has generated substantial debate and controversy, largely due to concerns about its potential for increasing suicide contagion. Critics have argued the series overlooked or ignored evidence[9-11] and media guidelines[12,13] suggesting suicide contagion is fostered by stories that sensationalize or promote simplistic explanations of suicidal behavior, glorify or romanticize the decedent, present suicide as a means of accomplishing a goal such as community change or revenge, or offer potential prescriptions of "how to" die by suicide.[14-17] Unlike most shows with a suicide theme, the creators of *13 Reasons Why* also depicted the lead character's suicide in graphic detail believing that showing viewers how disturbing and painful suicide is would be a deterrent for

others.[18] Netflix included warnings at the beginning of three episodes involving the sexual assaults and the suicide. A website was also launched with the release of the show that contained resources and referral information.[19] However, more than a month had passed after the series' release before Netflix strengthened the graphic content advisories and added a warning about the whole series; this warning only appeared before the initial episode.[20]

Like other Netflix series, after promoting the show in the months before the premiere, all episodes of *13 Reasons Why* were released simultaneously, allowing for unlimited viewing of episodes over a short-period of time (i.e., "binge-watching"). According to Netflix, *13 Reasons Why* was the third most binge-watched show of 2017, which they defined as viewing activity of more than 2 hours a day.[21] A recent editorial expressed concern that binge-watching *13 Reasons Why* may have a powerful influence on adolescents, whose brains are still developing the ability to inhibit risky behaviors and emotions.[22]

In this study, we aimed to evaluate the association between the release of *13 Reasons Why* and suicide rates in U.S. individuals aged 10 to 64. We hypothesized the release would have an immediate and sustained impact on suicide rates in youth and emerging adults,[23] because media failure to incorporate best suicide prevention practices is associated with increases in suicide in these age groups relative to adults.[6] We also evaluated sex-specific associations. We expected increases in youth suicide rates in both sexes after the series' release, and that girls would be particularly impacted because the show's protagonist was a teenage girl. Youth viewing patterns of *13 Reasons Why* revealed that strong identification with the lead female character was significantly correlated with the belief that the series increased individual suicide risk.[24] We also assessed homicide rates as a control outcome.

METHOD

Participants and Data Source

The Centers for Disease Control and Prevention's (CDC's) Web-based Wide-ranging Online Data for Epidemiologic Research (WONDER) was used to obtain annual and monthly data on deaths for which suicide (coded X60-X84, Y87.0, and *U03 for *International Classification of Diseases, Tenth Revision (ICD-10))* and homicide (coded X85-YY09, Y87.1, *U01-*U01) were listed as the underlying cause of death among 10- to 64-year-olds between January 1, 2013 and December 31, 2017.[25] The lower and upper age limits in this study were chosen to span 3 developmental periods: childhood and adolescence (10-17 years), emerging adulthood (18-29 years), and early-to-middle adulthood (30-64 years). Number of suicide deaths per month was extracted overall and by sex. Mean monthly counts and crude rates per 100,000 persons were calculated with WONDER population estimates.[25] This study was not considered human participant research according to the review policy of the Research Institute at Nationwide Children's Hospital.

Statistical Analysis

An interrupted time series segmented regression analysis[26,27] was used to compare suicide rates before and after the release of *13 Reasons Why*. Poisson regression models were used to estimate the suicide incidence rates and incidence rate ratios (IRRs) along with their 95% CIs within each targeted age group, and separately for male and female individuals. Initial analyses indicated overdispersion in the data (i.e., extra-Poisson variability) and so a more flexible quasi-Poisson model was used for all analyses.[28] The model provides independent tests of the underlying trend in suicide rates before the release of *13 Reasons Why*; the step change in level after the release; and the post-release trend. Youth suicide rates demonstrate a seasonal pattern with rates being highest in the fall and spring and lowest during summer months.[29] Seasonal variation in suicide rates was modeled using harmonic functions of time.[30] Although all episodes of *13 Reasons Why* were released on the same day, March 31, 2017, a promotional trailer for the series began airing on March 1, 2017. In our interrupted time series

analyses, we have managed the gap between promotion and release of the series in three ways: (1) Include March rates as part of the pre-release period (primary analysis); (2) Include March rates in the post-release period; and (3) Exclude March and look at the change between February and April. March was included as a pre-release month in the primary analysis since the show could be viewed for only one day (March 31, 2017), with 13 episodes, each roughly one-hour long.

The Holt-Winters' method[31] was used to produce forecasts of expected suicide rates after the release of *13 Reasons Why*. This approach uses a triple exponential smoothing model to forecast time series data - one equation for level, one for trend, and one for seasonality. The additive model form was selected because it displayed a better fit to the data than the multiplicative method, with smaller squared prediction errors. For these analyses, the pre-release period was defined as the 4 years and 2 months prior to the release of *13 Reasons Why*, i.e., from January 1, 2013 to February 28, 2017. The promotional period spanned March 1, 2017 through March 31, 2017. The post-release period spanned April 1, 2017 through December 31, 2017. The R Holt-Winters Filtering package identified optimal values of level, trend, and seasonality.[32] Using rates from the pre-release period, the model provides predicted suicide rates for the promotional and post-release periods along with 95% prediction intervals. The estimated number of additional suicides after the series' release was calculated by summing the difference in observed and expected deaths between April 1, 2017 and December 31, 2017, obtained from the Holt-Winters forecasting model. A 95% confidence interval for the difference in deaths was calculated using the Poisson distribution and test-based methods.[33]

To distinguish any association with the release of *13 Reasons Why* from other concurrent events a control analysis was also performed using homicide as the outcome.[26,34] Homicide is unlikely to be affected by the series' release but is similar to suicide in that it is also influenced by social and environmental events.[35] Finding an association with suicide but not

homicide provides stronger evidence to support a link between the series' release and suicide. In contrast, the presence of an association between the series' release and both suicide and homicide would indicate that the change may be attributable to other factors. We used similar models and tests for the outcome of homicide as described above for suicide.

Statistical analyses were performed with R statistical software version 3.4.1 (R Foundation for Statistical Computing, Vienna, Austria) and Stata/IC Statistical Software, Release 15.0 (StataCorp, College Station, TX). Significance was based on 95% CIs for interrupted time series regression models and 95% prediction intervals (PIs) for forecasting models. 95% CIs that did not include 1.00 were considered statistically significant. Observed suicide rates that fell outside the 95% PIs were considered statistically significant.

RESULTS

Between January 1, 2013 and December 31, 2017, a total of 180,655 suicide deaths occurred in individuals aged 10 to 64 years in the US. Most suicide decedents were male individuals (n=137,838 [76.3%]), with a male-to-female IRR of 3.22 (95% CI, 3.02-3.44). **Table 1** displays the mean monthly counts and rates of suicide before and after the release of *13 Reasons Why* on March 31, 2017. In the months before the series' release, suicide rates in 10- to 17-year-olds showed a significantly increasing trend. After accounting for seasonal effects and the underlying trend, we found that the release of *13 Reasons Why* was associated with a 28.9% step increase in the April 2017 suicide rate (95% CI=1.09-1.53; *P*=.004) among 10- to 17-year-old youth. The April 2017 suicide rate of 0.57 per 100,000 persons was the highest monthly suicide rate of any month during the 5-year study period. Following this spike, there was a non-significant decline from April through December, 2017 (IRR=0.97, 95% CI=0.95-1.00; *P*=.057).

When the observed and forecasted rates of youth suicide were graphed based on the Holt-Winters analysis, there was a visible and statistically significant effect of the release of *13*

Reasons Why on subsequent suicide (**Figure 1**), with observed rates in April, June, and December being significantly higher than corresponding rates forecasted using Holt-Winters modeling. Interestingly, the observed rate in the month of March (promotional period) is also statistically significantly higher than the model forecast. In absolute numbers, we estimated 195 (95% CI, 168-222) additional suicide deaths among 10- to 17-year-old youths occurred between April 1 and December 31, 2017, following the series' release. To test whether the April, 2017 spike accounted for the excess number of suicide deaths after the release of 13 Reasons Why, we calculated the difference in observed and expected suicide deaths removing April, 2017 and still observed 137 excess suicide deaths [95% CI, 114-160] between May, 2017 and December, 2017. Among 10- to 17-year-olds, results of separate analyses that (1) excluded March, 2017 and (2) included March, 2017 as a post-event were consistent with the primary interrupted time series analyses (**Tables S1 and S2, available online**).

We hypothesized that the release of *13 Reasons Why* would have a larger impact on suicide in girls than boys. When analyses were stratified by sex, a statistically significant increase in suicide rates was observed for boys in keeping with overall results in the 10- to 17-year-old age group (IRR=1.35, 95% CI=1.12-1.64; Table 1 and **Figure S1, available online)**. Although the mean monthly count and rate of suicide for female children and adolescents increased after the series' release, the difference was not statistically significant (IRR=1.15; 95% CI=0.89-1.50), with no change in post-release trends (IRR=0.97, 95% CI=0.93-1.01). Observed suicide rates for 10- to 17-year-old girls in June, 2017 were significantly greater than corresponding forecasted rates, but observed rates in September were significantly lower than expected rates (Figure S1, available online).

In contrast to findings for children and adolescents, analysis of suicide rates in 18- to 29-year-olds and 30- to 64-year-olds showed no statistically significant increase in the suicide rate immediately following the release of *13 Reasons Why*; there also was no change in post-release

trends. When stratified by sex, statistically significant increases in suicide were not observed for older age-stratified groups of male and female individuals (Table 1).

Results of the control analyses revealed no significant changes in homicide rates in any of the targeted age groups (**Table 2, Tables S3 and S4, available online**). Sensitivity analyses that used negative binomial regression to correct for overdispersion produced results similar to findings obtained by quasi-Poisson regression models, for both suicide and homicide outcomes (**Tables S5 and S6, available online**).

DISCUSSION

This national study identified an increase in suicide rates for children and adolescents aged 10 to 17 years after the release of the first season of the Netflix series *13 Reasons Why*. We estimate that the series' release was associated with approximately 195 additional suicide deaths in 2017 for 10- to 17-year-olds. Control analyses found no evidence of a significant change in homicide rates over the same time period for any of the studied age groups. In contrast to the observed increase in youth suicide in association with the release of *13 Reasons Why*, suicide rates for adults aged 18-29 years and 30-64 years did not show a significant increase. This finding highlights previous reports that youth may be particularly vulnerable to suicide contagion.[6,7] Study findings are particularly troubling given that some mental health professionals and advocates had previously expressed concerns that the release of *13 Reasons Why* might actually promote suicide.[15,17]

The increase in the youth suicide rate that occurred after the initial release of *13 Reasons Why* provides an example of potential unintended negative consequences of media portrayals of suicide that do not adhere to best practices. However, it is possible to portray suicide in a way that cultivates hope by increasing awareness of available supports for those who struggle with suicidal thoughts or behaviors.[3] Accurate, humanizing depictions of an

individual coping with suicidal thoughts, seeking help when distressed, and modeling resilience may, in fact, reduce suicidal behaviors,[36] but this has yet to be tested in fictional accounts. Media and entertainment professionals understandably value freedom of expression and might equate responsible messaging with censorship, as much still remains to be learned about suicide contagion and how media might best contribute to suicide prevention efforts. Nevertheless, study findings should encourage dialogue and reflection within the entertainment industry about balancing creative license and the medical dictum “primum non nocere” - “first do no harm”.[16]

Contrary to expectations, data from this study did not conclusively demonstrate that the release of *13 Reasons Why* was associated with increased suicide rates in 10- to 17-year-old girls. Reasons for this finding are unclear. Previous studies indicate that suicide contagion disproportionately affects those who strongly identify with the person who died by suicide (particularly celebrities).[11,37-39] Numerous media outlets failed to adhere to guidelines for suicide reporting after the death of the actor Robin Williams. This resulted in a roughly 10% increase in suicide deaths in the subsequent five months, representing an excess of 1,841 cases.[40] In that instance, male individuals had the greatest increase in excess suicide events especially from suffocation/hanging, strengthening the case for modeling and identification.[37,38,41] Imitation may have contributed to the increase in the male youth suicide rate after the release of *13 Reasons Why*, given a male adolescent character made a serious suicide attempt by firearm at the end of the series. A well-known gender paradox in suicide also exists, with male rates of suicide being higher than female rates and female rates of attempted suicide being higher than male rates across the lifespan.[42] Rates of hospitalizations for suicidal behavior have increased steadily among youth over the last decade, with female rates increasing more rapidly than male rates.[43] Although non-fatal suicide attempt rates may have increased for girls after the release of *13 Reasons Why*, national monthly suicide attempt data were not available to address this

question. Finally, the book on which the series was based has been on the *New York Times* best sellers list during the past decade,[44] with its 10th anniversary re-release in 2016.[45] Given the likely preponderance of female readership, there may have been some degree of desensitization among girls prior to the Netflix series original release.

This study has several important limitations. First, the quasi-experimental design of our study limits our ability to draw any causal conclusions between the release of *13 Reasons Why* and increased suicide rates in young people in the U.S. Nevertheless, the time series and forecasting approaches employed in this study allow us to make credible inferences about this association. The initial increase in youth suicide rates in the month immediately following the series release is concordant with a prior report showing a spike in Internet searches about suicide in the month following release,[46] and a small single-hospital study showing an increase in suicide attempt admissions after the series' premiere.[47] Second, we were unable to assess whether the observed increase in youth suicide rates was attributable to the portrayal of suicide in the series, a lack of adherence to media guidelines (e.g., failure to provide national suicide prevention resources until later months), or other factors. The observation that the series was first released on March 31, 2017 and suicide rates increased that month also raises questions about effects of pre-release media promotion of the series premiere. Third, we did not examine the impact of *13 Reasons Why* on specific methods of suicide (e.g., suicide by cutting) due to small cell sizes, which would result in unstable estimates. Fourth, there may have been other events or unmeasured factors that occurred during the study period that might be associated with increased suicide rates. Fifth, our study may have lacked sufficient statistical power to detect a significant association in 10- to 17-year-old girls. Finally, as with most studies looking at possible contagion, we have little understanding of "dose" or context, including who specifically watched the series, when they watched, whether they binge-watched, if it was further discussed in peer-groups, how secondary discussions may have influenced vulnerable individuals, and

whether the subsequent focus on suicide prevention may have actually mitigated some of the pronounced contagion effects.

In conclusion, we found a significant increase in suicide rates among US children and adolescents in the month after the release of *13 Reasons Why*. Suicide rates in two subsequent months remained elevated over forecasted rates, resulting in 195 additional deaths. There is no discernible public health benefit associated with viewing the series, and caution regarding the exposure of children and adolescents is warranted. As the second season of the series is now underway, and a 3rd season is planned, continued surveillance is needed to monitor potential consequences on suicide rates in association with viewing the series.

ACCEPTED MANUSCRIPT

REFERENCES

1. Hedegaard H, Curtin SC, Warner M. Suicide Mortality in the United States, 1999-2017. *NCHS data brief.* 2018(330):1-8.
2. U.S. Department of Health and Human Services (HHS) Office of the Surgeon General and National Action Alliance for Suicide Prevention. *National Strategy for Suicide Prevention: Goals and Objectives for Action. Washington, DC: HHS, September 2012.* 2012.
3. National Recommendations for Depicting Suicide. Available at: https://theactionalliance.org/messaging/entertainment-messaging/national-recommendations; last accessed 03/15/2019.
4. Sisask M, Varnik A. Media roles in suicide prevention: a systematic review. *Int J Environ Res Public Health.* 2012;9(1):123-138.
5. Gould MS. Suicide and the media. *Annals of the New York Academy of Sciences.* 2001;932:200-221; discussion 221-204.
6. Gould M, Jamieson P, Romer D. Media Contagion and Suicide Among the Young. *American Behavioral Scientist.* 2003;46(9):1269-1284.
7. Ackerman J, Cannon EA, Stage DL, Singer JB, Young N. Suicide Reporting Recommendations: Media as Partners in Suicide Prevention; Available at: https://workforce.mha.ohio.gov/Workforce-Development/Health-Professionals/Suicide-Prevention-Training/Ohio-Suicide-Reporting-Guidelines; last accessed: 01/12/2019. 2018.
8. Asher J. *Thirteen Reasons Why.* New York, NY: RazorBill/Penguin 2007.
9. Ortiz P, Khin Khin E. Traditional and new media's influence on suicidal behavior and contagion. *Behavioral sciences & the law.* 2018;36(2):245-256.

10. Pirkis J, Blood RW. Suicide and the media. Part II: Portrayal in fictional media. *Crisis.* 2001;22(4):155-162.

11. Insel BJ, Gould MS. Impact of modeling on adolescent suicidal behavior. *Psychiatr Clin North Am.* 2008;31(2):293-316.

12. Recommendations for Reporting on Suicide. Available at: http://reportingonsuicide.org/; last accessed 01/22/2019.

13. Mental Illness and Suicide: A Mindframe Resource for Stage and Screen; Available at: http://www.mindframe-media.info/__data/assets/pdf_file/0014/6017/Stage-and-Screen-Resource-Book.pdf; last accessed: 01/22/2019.

14. Saint-Louis C. For Families of Teens at Suicide Risk, '13 Reasons' Raises Concerns. *The New York Times*2017.

15. Koplewicz H. '13 Reasons Why' Spreads Suicide like a Disease: Column. Available at: https://www.usatoday.com/story/opinion/2017/05/05/13-reasons-why-suicide-mental-health-dangerous-column/101262330/; last accessed: 5/14/2018.

16. Campo JV, Bridge JA. Exploring the Impact of 13 Reasons Why: Looking for Light Amidst the Heat. *Journal of the American Academy of Child and Adolescent Psychiatry.* 2018;57(8):547-549.

17. Kutner M. Suicide Prevention Expert on '13 Reasons Why': 'Contagion is a real concern here'; Available at: https://www.newsweek.com/netflix-13-reasons-why-suicide-contagion-experts-593367; last accessed: 01/18/2019. 2017.

18. '13 Reasons Why' Creator on its "Nakedly Honest" Portrayal of Teen Suicide. Available at: https://www.hollywoodreporter.com/live-feed/13-reasons-why-netflix-suicide-drama-selena-gomez-990132; last accessed: 5/15/2018.

19. 13 Reasons Why. Available at: https://13reasonswhy.info/; last accessed: 03/11/2019.

20. Yandoli KL. Netflix is Updating Its Trigger Warnings for " 13 Reasons Why". Available at: https://www.buzzfeednews.com/article/krystieyandoli/netflix-is-updating-its-trigger-warnings-for-13-reasons-why; last accessed 03/14/2019. 2017.

21. 2017 on Netflix - A Year in Bingeing; Netflix Media Center: https://media.netflix.com/en/press-releases/2017-on-netflix-a-year-in-bingeing; last accessed, 01/17/2019.

22. O'Brien KHM, Knight JR, Jr., Harris SK. A Call for Social Responsibility and Suicide Risk Screening, Prevention, and Early Intervention Following the Release of the Netflix Series 13 Reasons Why. *JAMA internal medicine.* 2017;177(10):1418-1419.

23. Arnett JJ, Zukauskiene R, Sugimura K. The new life stage of emerging adulthood at ages 18-29 years: implications for mental health. *The lancet Psychiatry.* 2014;1(7):569-576.

24. Hong V, Ewell Foster CJ, Magness CS, McGuire TC, Smith PK, King CA. 13 Reasons Why: Viewing Patterns and Perceived Impact Among Youths at Risk of Suicide. *Psychiatric services (Washington, DC).* 2018:appips201800384.

25. Centers for Disease Control and Prevention. Multiple Cause of Death Data, Suicide mortality query; Produced by the Division of Vital Statistics, National Center for Health Statistics (NCHS), CDC, United States Department of Health and Human Services (US DHHD); https://wonder.cdc.gov/mcd.html (last accessed: 01/13/2019). 2019.

26. Wagner AK, Soumerai SB, Zhang F, Ross-Degnan D. Segmented regression analysis of interrupted time series studies in medication use research. *J Clin Pharm Ther.* 2002;27(4):299-309.

27. Bernal JL, Cummins S, Gasparrini A. Interrupted time series regression for the evaluation of public health interventions: a tutorial. *Int J Epidemiol.* 2017;46(1):348-355.

28. Hoef JMV, Boveng PL. Quasi-Poisson vs. negative binomial regression: how should we model overdispersed count data? *Ecology.* 2007;88:2766-2772.

29. Centers for Disease Control and Prevention, National Center for Health Statistics. Underlying Cause of Death 1999-2017 on CDC WONDER Online Database, released December, 2018. Monthly Suicide Data for 10- to 17-Year-Olds are from the Multiple Cause of Death Files, 1999-2017,as compiled from data provided by the 57 vital statistics jurisdictions through the Vital Statistics Cooperative Program. Last accessed at http://wonder.cdc.gov/ucd-icd10.html 03/14/2019.

30. Hunsberger S, Albert PS, Follmann DA, Suh E. Parametric and semiparametric approaches to testing for seasonal trend in serial count data. *Biostatistics.* 2002;3(2):289-298.

31. Montgomery DC, Johnson LA, Gardiner JS. *Forecasting & Time Series.* 2nd ed. New York, NY: McGraw-Hill; 1990.

32. RDocumentation. Holt-Winters Filtering: Available at: https://www.rdocumentation.org/packages/stats/versions/3.5.2/topics/HoltWinters; last accessed: 01/18/2019.

33. Sahai H, Kurshid A. *Statistics in Epidemiology: Methods, Techniques, and Applications.* Boca Raton, FL: CRC Press; 1996.

34. Lopez Bernal J, Cummins S, Gasparrini A. The use of controls in interrupted time series studies of public health interventions. *Int J Epidemiol.* 2018;47(6):2082-2093.

35. Humphreys DK, Gasparrini A, Wiebe DJ. Evaluating the Impact of Florida's "Stand Your Ground" Self-defense Law on Homicide and Suicide by Firearm: An Interrupted Time Series Study. *JAMA internal medicine.* 2017;177(1):44-50.

36. Niederkrotenthaler T, Voracek M, Herberth A, et al. Role of media reports in completed and prevented suicide: Werther v. Papageno effects. *The British journal of psychiatry : the journal of mental science.* 2010;197(3):234-243.

37. Blood RW, Pirkis J. Suicide and the media. Part III: Theoretical issues. *Crisis.* 2001;22(4):163-169.

38. Niederkrotenthaler T, Till B, Kapusta ND, Voracek M, Dervic K, Sonneck G. Copycat effects after media reports on suicide: a population-based ecologic study. *Soc Sci Med.* 2009;69(7):1085-1090.

39. Cheng AT, Hawton K, Lee CT, Chen TH. The influence of media reporting of the suicide of a celebrity on suicide rates: a population-based study. *Int J Epidemiol.* 2007;36(6):1229-1234.

40. Fink DS, Santaella-Tenorio J, Keyes KM. Increase in suicides the months after the death of Robin Williams in the US. *PLoS One.* 2018;13(2):e0191405.

41. Stack S. Media coverage as a risk factor in suicide. *Journal of Epidemiology & Community Health.* 2003;57(4):238-240.

42. Goldsmith SK, Pellmar TC, Kleinman AM, Bunney WE. *Reducing Suicide: A National Imperative.* Washington, D.C.: National Academy Press; 2002.

43. Plemmons G, Hall M, Doupnik S, et al. Hospitalization for Suicide Ideation or Attempt: 2008-2015. *Pediatrics.* 2018;141(6).

44. Rich M. A Story of a Teenager's Suicide Quietly Becomes a Bestseller. The New York Times; Available at: https://www.nytimes.com/2009/03/10/books/10why.html; last accessed 01/21/2019. 2009.

45. Asher J. *Thirteen Reasons Why.* 10th Anniversary Edition ed. New York, NY: Penguin Teen; 2016.

46. Ayers JW, Althouse BM, Leas EC, Dredze M, Allem JP. Internet Searches for Suicide Following the Release of 13 Reasons Why. *JAMA internal medicine.* 2017;177(10):1527-1529.

47. Cooper MT, Jr., Bard D, Wallace R, Gillaspy S, Deleon S. Suicide Attempt Admissions From a Single Children's Hospital Before and After the Introduction of Netflix Series 13 Reasons Why. *The Journal of adolescent health : official publication of the Society for Adolescent Medicine.* 2018;63(6):688-693.

ACCEPTED MANUSCRIPT

Table 1. Association Between the Release of *13 Reasons Why* and Suicide in the United States, by Age Group

Characteristic	Mean Monthly Count		Mean Monthly Rate per 100,000 Persons		Pre-13RW Trend[a] (IRR) (95% CI)	*p*	Post-13RW Trend[b] (IRR) (95% CI)	*p*	Step Change[c] (IRR) (95% CI)	*p*
	Pre-13RW	Post-13RW	Pre-13RW	Post-13RW						
10 to 17 Years										
Overall	116.29	149.56	0.35	0.45	1.005 (1.003-1.008)	<.001	0.97 (0.95-1.00)	.057	1.29 (1.09-1.53)	.004
Sex										
Female	35.67	42.00	0.22	0.26	1.007 (1.003-1.010)	<.001	0.97 (0.93-1.01)	.163	1.15 (0.89-1.50)	.279
Male	80.63	107.56	0.47	0.63	1.005 (1.002-1.007)	<.001	0.97 (0.94-1.00)	.098	1.35 (1.12-1.64)	.002
18 to 29 Years										
Overall	651.14	774.22	1.22	1.43	1.004 (1.003-1.005)	<.001	0.99 (0.98-1.01)	.443	1.07 (0.98-1.18)	.135
Sex										
Female	120.37	143.56	0.46	0.54	1.003 (1.001-1.005)	.006	0.98 (0.95-1.01)	.252	1.15 (0.97-1.38)	.111
Male	530.76	630.67	1.94	2.29	1.004 (1.003-1.005)	<.001	1.00 (0.98-1.01)	.675	1.05 (0.96-1.16)	.285
30 to 64 Years										
Overall	2193.35	2371.22	1.50	1.60	1.001 (1.000-1.002)	.060	1.00 (0.99-1.01)	.914	1.03 (0.95-1.12)	.448
Sex										
Female	549.76	572.33	0.74	0.77	1.002 (1.000-1.003)	.008	0.99 (0.98-1.01)	.465	1.00 (0.90-1.11)	.980
Male	1643.59	1798.89	2.29	2.48	1.001 (1.000-1.002)	.184	1.00 (0.99-1.02)	.879	1.04 (0.96-1.13)	.333

Note: 13RW = *13 Reasons Why;* IRR = incidence rate ratio.
[a] Time period from January 1, 2013 to March 31, 2017
[b] Time period from April 1, 2017 to December 31, 2017
[c] Refers to changes in suicide rates during the first month following the release of *13 Reasons Why* on March 31, 2017

ACCEPTED

Table 2. Association Between the Release of *13 Reasons Why* and Homicide in the United States, by Age Group

Characteristic	Mean Monthly Count		Mean Monthly Rate per 100,000 Persons		Pre-13RW Trend[a] (IRR) (95% CI)	*p*	Post-13RW Trend[b] (IRR) (95% CI)	*p*	Step Change[c] (IRR) (95% CI)	*p*
	Pre-13RW[a]	Post-13RW	Pre-13RW	Post-13RW						
10 to 17 Years										
Overall	63.31	75.56	0.19	0.23	1.007 (1.004-1.009)	<.001	0.99 (0.96-1.02)	.551	1.01 (0.82-1.24)	.913
Sex										
Female	-	-	-	-						
Male	51.10	60.78	0.30	0.36	1.006 (1.004-1.009)	<.001	0.99 (0.96-1.03)	.680	1.00 (0.80-1.25)	.995
18 to 29 Years										
Overall	548.92	616.89	1.03	1.14	1.006 (1.005-1.008)	<.001	0.99 (0.97-1.01)	.214	0.96 (0.85-1.08)	.497
Sex										
Female	74.24	85.56	0.28	0.32	1.006 (1.004-1.008)	<.001	0.99 (0.97-1.02)	.690	0.97 (0.82-1.15)	.725
Male	474.69	531.33	1.74	1.93	1.006 (1.005-1.008)	<.001	0.99 (0.96-1.01)	.214	0.96 (0.83-1.09)	.512
30 to 64 Years										
Overall	692.29	813.44	0.47	0.55	1.006 (1.005-1.007)	<.001	1.00 (0.98-1.02)	.983	0.95 (0.86-1.05)	.315
Sex										
Female	150.08	172.11	0.20	0.23	1.004 (1.002-1.006)	<.001	1.02 (0.99-1.04)	.225	0.92 (0.79-1.08)	.322
Male	542.22	641.33	0.75	0.88	1.006 (1.005-1.008)	<.001	1.00 (0.98-1.01)	.645	0.96 (0.86-1.06)	.415

Note: 13RW = *13 Reasons Why;* IRR = incidence rate ratio.
[a] Time period from January 1, 2013 to March 31, 2017
[b] Time period from April 1, 2017 to December 31, 2017
[c] Refers to changes in suicide rates during the first month following the release of *13 Reasons Why* on March 31, 2017

ACCEPTED

ACCEPTED MANUSCRIPT

Figure 1. Association Between the Release of *13 Reasons Why* and Suicide Rates in 10- to 17-Year-Old Children and Adolescents in the United States

Note: Blue circles indicate observed suicide rates between January 1, 2013 and December 31, 2017. Orange solid line indicates fitted values that best account for underlying level, trend, and seasonal variation prior to release. The leading edge of the shaded area indicates the initial airing of the 13 Reasons Why trailer. The trailing edge of the shaded area indicates the release date of 13 Reasons Why. Orange triangles indicate forecasted suicide rates; curved orange dashed lines indicate the upper and lower 95% prediction intervals. Observed suicide rates in March, April, June, and December 2017 were significantly higher than corresponding forecasted rates.

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

Association Between the Release of Netflix's *13 Reasons Why* and Suicide Rates in the United States: An Interrupted Times Series Analysis

Jeffrey A. Bridge, PhD, Joel B. Greenhouse, PhD, Donna Ruch, PhD, Jack Stevens, PhD, John Ackerman, PhD, Arielle H. Sheftall, PhD, Lisa M. Horowitz, PhD, MPH, Kelly J. Kelleher, MD, John V. Campo, MD

Funding/Support: Dr. Bridge was supported by grant R01-MH117594 from the National Institute of Mental Health, National Institutes of Health.

Role of the Sponsor:
The Extramural Division of the National Institute of Mental Health did not participate in the design and conduct of the study, in the collection, analysis, and interpretation of the data, or in the preparation, review, or approval of the manuscript.

Author Contributions:
Dr. Bridge had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Bridge, Greenhouse, Ruch, Stevens, Kelleher, Campo
Acquisition of data: Bridge, Ruch
Analysis and interpretation of data: All authors
Drafting of the manuscript: Bridge
Critical revision of the manuscript for important intellectual content: All authors
Statistical analysis: Bridge, Greenhouse, Ruch
Obtained funding: Bridge
Administrative, technical, or material support: Bridge, Ruch
Study supervision: Bridge, Greenhouse, Kelleher, Campo

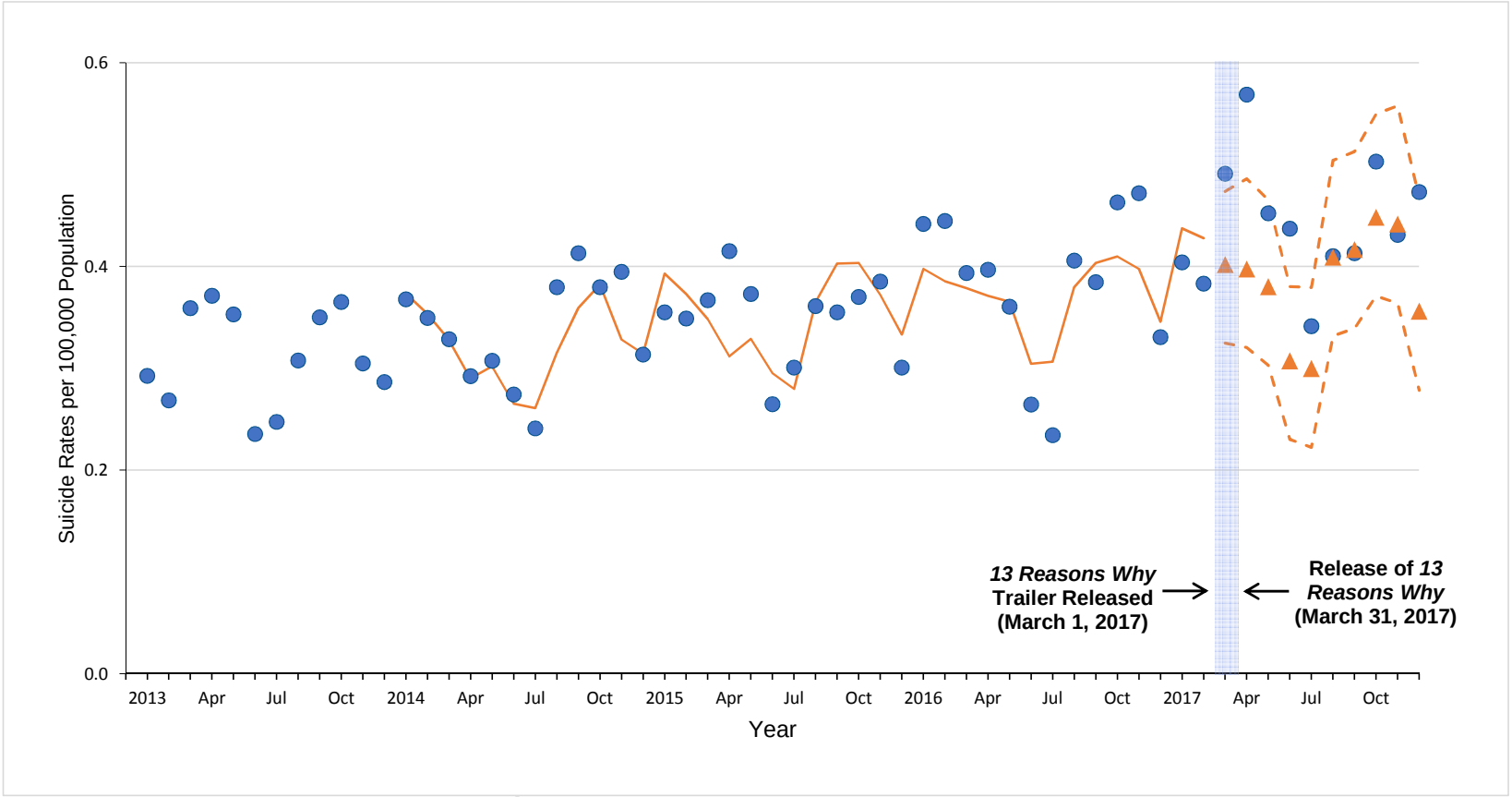
Drs. Bridge, Greenhouse, and Ruch served as the statistical experts for this research.

Disclosures:
Dr. Bridge has served on the Scientific Advisory Board of Clarigent Health.

Drs. Greenhouse, Ruch, Stevens, Ackerman, Sheftall, Horowitz, Kelleher, and Campo report no biomedical financial interests or potential conflicts of interest.

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT



ACCEPTED MANUSCRIPT

Year	X-Axis	Month	Observed Deaths	Fitted	Forecast	Upper 95	Lower 95
2013	2013	1	0.29263404				
2013		2	0.268499255				
2013		3	0.359004647				
2013	Apr	4	0.371072024				
2013		5	0.352970958				
2013		6	0.235313967				
2013	Jul	7	0.247381344				
2013		8	0.307718247				
2013		9	0.349954098				
2013	Oct	10	0.365038335				
2013		11	0.304701418				
2013		12	0.286600351				
2014	2014	13	0.367611974	0.373157591			
2014		14	0.349532694	0.353419214			
2014		15	0.328440189	0.327846915			
2014	Apr	16	0.292281657	0.289767295			
2014		17	0.307347715	0.301828891			
2014		18	0.274202377	0.265300393			
2014	Jul	19	0.241057023	0.260714203			
2014		20	0.379664809	0.315197289			
2014		21	0.412810147	0.359036505			
2014	Oct	22	0.379664809	0.38205421			
2014		23	0.394730866	0.328174293			
2014		24	0.313374132	0.314227611			
2015	2015	25	0.354880244	0.392883897			
2015		26	0.34886533	0.372763693			
2015		27	0.36691007	0.348185897			
2015	Apr	28	0.415029436	0.311605603			

ACCEPTED MANUSCRIPT

ACCEPTED MANUSCRIPT

2015		29	0.372924984	0.328620404			
2015		30	0.264656454	0.295040309			
2015	Jul	31	0.300745964	0.279631197			
2015		32	0.360895157	0.364783704			
2015		33	0.354880244	0.402834505			
2015	Oct	34	0.369917542	0.403148115			
2015		35	0.38495484	0.371895105			
2015		36	0.300745964	0.332972407			
2016	2016	37	0.441634446	0.397610992			
2016		38	0.444638759	0.385353595			
2016		39	0.393565387	0.37856999			
2016	Apr	40	0.396569699	0.371101886			
2016		41	0.360517919	0.365238696			
2016		42	0.264379799	0.304427207			
2016	Jul	43	0.234336644	0.306333214			
2016		44	0.405582637	0.379470199			
2016		45	0.384552419	0.403420806			
2016	Oct	46	0.462664634	0.409783602			
2016		47	0.471677601	0.397554398			
2016		48	0.330474734	0.345532089			
2017	2017	49	0.404043078	0.437232107			
2017		50	0.383092672	0.427583188			
2017		51	0.490838000		0.401905000	0.473419994	0.3247208
2017	Apr	52	0.568653226		0.397419602	0.486113012	0.3201828
2017		53	0.451929659		0.380200297	0.465220988	0.302906096
2017		54	0.436965078		0.307358801	0.380061001	0.230002403
2017	Jul	55	0.341191918		0.299696296	0.379144996	0.222273007
2017		56	0.410028875		0.409049302	0.504110992	0.331553996
2017		57	0.413021803		0.416692406	0.512674987	0.339119703
2017	Oct	58	0.502809167		0.448359311	0.549556971	0.370704114
2017		59	0.430979282		0.441510707	0.557512999	0.363767207

ACCEPTED MANUSCRIPT

2017	60	0.472880036	0.356182307	0.467103988	0.278344899	

ACCEPTED MANUSCRIPT